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Technical Bullet Series on Clay Brick Pavers

#4 – Designing For Heavy Vehicular Traffic

Abstract – This Tech Bullet focuses on designing pavements for extremely heavy vehicular traffic. The focus is on the bituminous setting system, which is the most durable system according to Pine Hall Brick's field experience and ICPI's Waterloo Study.

The typical residential driveway or light traffic commercial job where an occasional garbage truck or tractor trailer might pass does not qualify as heavy vehicular traffic and is typically designed using pavers that meet ASTM C902 for Pedestrian and Light Traffic Paving Brick.

Picture 1: Heavy Vehicular Brick Paving

Officially Heavy Vehicular Traffic is defined as “high volumes of heavy vehicles representing trucks or combination vehicles having three, four or more loaded axles with daily equivalent single axle loads (ESAL) of 250 or greater." The majority of this Tech Note is going to focus on designing for the most difficult heavy vehicular applications like crosswalks, intersections and roadway applications, which require pavers that meet ASTM C1272 standards for Heavy Vehicular Paving Brick.

Bituminous Setting System

The most robust design detail is laying pavers on a bituminous setting bed over a concrete base with concrete headers. Interlocking Concrete Pavement Institute’s (ICPI) recent study of crosswalks performed by the University of Waterloo in Canada concluded that the bituminous system was almost 4 times as durable as the next best setting system for vehicular traffic applications.

The bituminous system is detailed as followed in Figure 1.

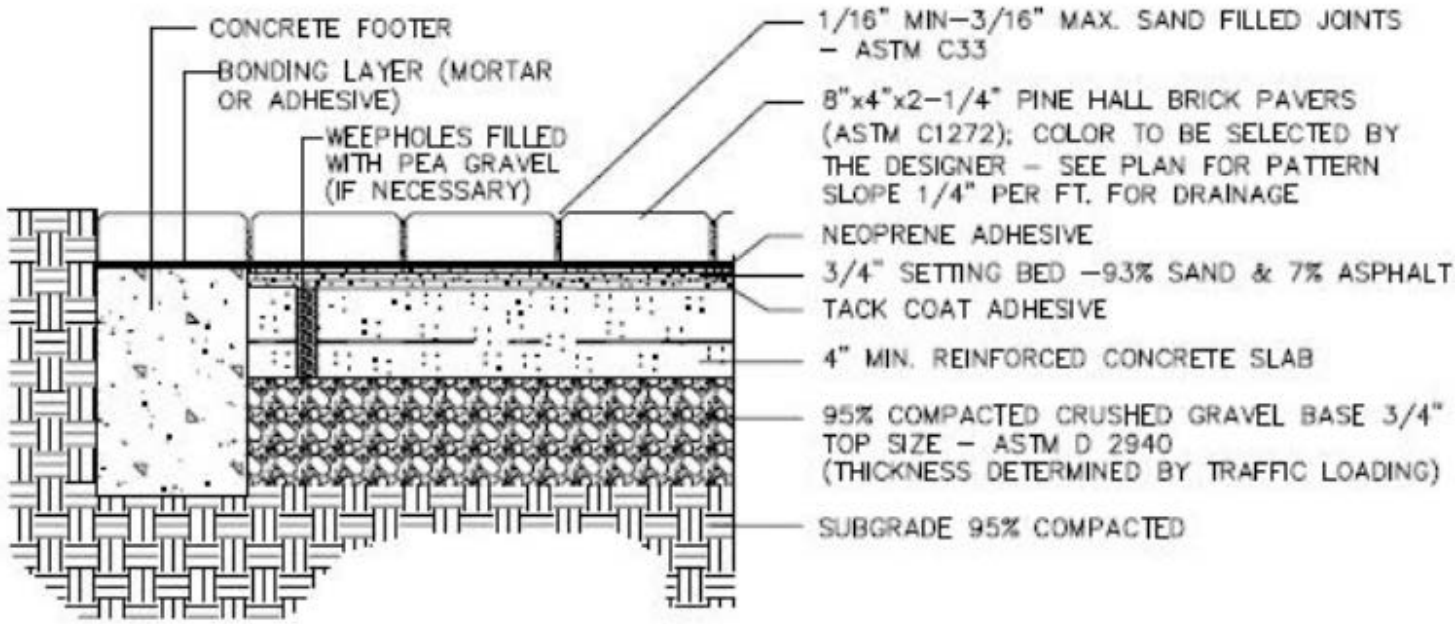

Figure 1: Bituminous CAD Detail.

The bituminous system provides increased durability because it relies on both adhesion and frictional interlock. The pavers are adhered to the asphalt tack coat with a neoprene adhesive while the asphalt tack coat binds to the reinforced concrete slab. ASTM C33 sand is then compacted into the joints similar to other paving systems. The system is much less susceptible to paver creep caused by sand loss, which is typically the biggest reason sand-set interlocking pavement systems fail.

The bituminous system is moderately more expensive to install and requires a more skilled contractor than other setting systems, but in the most rigorous of applications its functionality is far superior.

Sand-Set Over Rigid Base Setting System

The sand-set over rigid base system is extremely common in vehicular applications. It consists of pouring a concrete “bath tube” consisting of a reinforced concrete slab and a DOT approved curb. An inch of ASTM C33 sand is screeded for a bedding course and the pavers are then installed with ASTM C33 sand also used in the joints between the pavers to provide interlock.

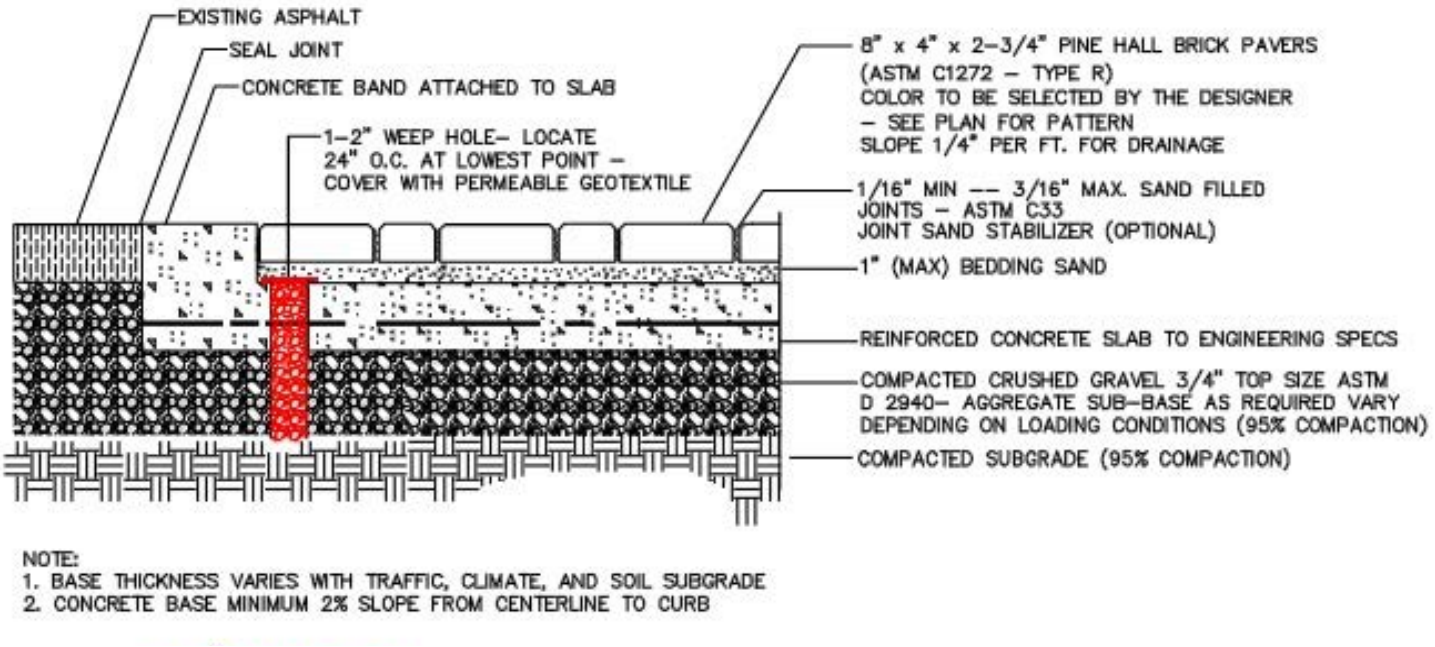

Figure 2: Sand-Set Over Rigid Base CAD Detail

Sand-Set Over Flexible Base Setting System

A sand-set over a flexible base setting system consists of a crushed gravel base compacted to 95% Proctor Density along with an appropriate DOT edge restraint. An inch of ASTM C33 sand is screeded over the crushed gravel base for a bedding course and the pavers are then installed with ASTM C33 sand also used in the joints between the pavers to provide interlock.

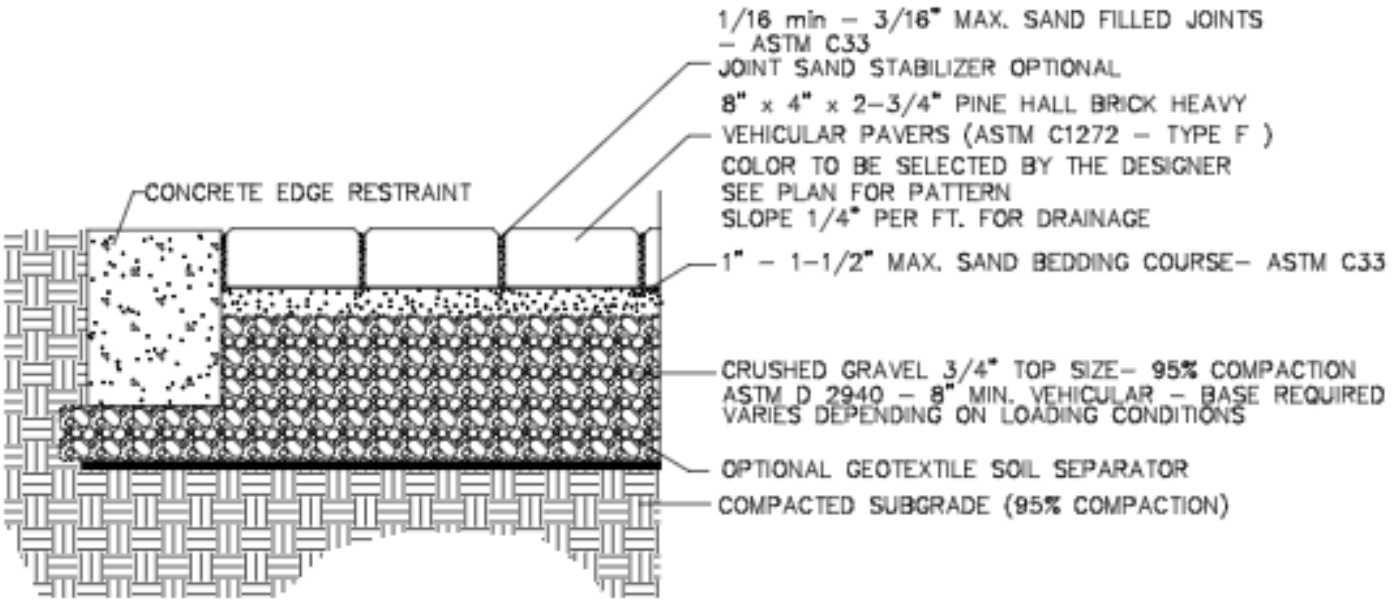

Figure 3: Sand-Set Over Rigid Base CAD Detail

Differences Between 3 Systems

ICPI's Waterloo Study estimated that the maximum lifetime ESALs of Bituminous Set was 7,000,000 compared to 2,000,000 for Sand-Set Over Rigid Base and 700,000 for Sand-Set Over Flexible Base.

Both Sand-Set systems are likely to develop paver creep if interlock is not established with an adequate sand joint or improper sand is used in the joints. In addition, the Sand-Set Over Flexible Base is more likely to develop to rutting due to inadequate compaction of the base. The adhesion of the pavers to the base in a bituminous system makes those type failures much less likely.

Sand-Set Over Flexible Base is the least costly to install and is the easiest and cheapest to repair if there are issues below the pavement. Sand-Set Over Rigid Base is more expensive than Sand-Set Over Flexible Base due to the added cost of the concrete slab, but less expensive than Bituminous Set. Bituminous Set is also the most difficult to repair as pavers cannot be picked-up and reused like the other two systems and patching small areas is difficult.

In general, both Sand-Set Over a Rigid Base and Sand-Set over a Flexible Base work well in projects that will receive light and medium vehicular traffic, but issues tend to arise when installed in the most rigorous applications.

Design Considerations

It is important to note that the crosswalks used for testing in the Waterloo Study sourced the highest quality materials, which were inspected prior to installation using experienced contractors following the most up-to-date industry standards. For best results in heavy vehicular application, Pine Hall Brick recommends following a similar protocol and paying special consideration to the following design considerations.

Pattern: For vehicular traffic, the herringbone pattern is universally recommended as the nature of this pattern dissipates traffic loads more effectively than any other pattern. In confined areas likes crosswalks; a 45-degree herringbone is recommended to avoid the tendency of joint widths being widened, in a 90-degree herringbone to avoid partial cuts at the edge restraint.

Edge Restraint: An adequate edge restraint is important to the proper functioning of any pavement functioning of any segmental paving system, vehicular or pedestrian. For heavy vehicular applications the use of a DOT approved concrete curbing is recommended. The concrete should allow the pavers to be laid flush with the concrete with no greater than a 1/8” gap between the pavers and the curb.

Joint Width: Research indicates that a 3mm (1/8") joint size is optimum for generating the strongest interlock between the individual units. Our English Edge paver features spacer nibs to aid the installer in creating optimal and consistent joint widths for good interlock. Joint width specifications should call for a range between 1/16” & 3/16”.

Bedding & Joint Sand: We recommend that bedding sand conform to ASTM C33. Hard angular sand with a variation in particle shape and size is ideal. Soft sands will break down into small particles under loading and settle down in the joints, which can comprise interlock over time. Sands with more rounded particles tend to form a looser structural matrix that is more susceptible to sand loss.

We recommend that the joint sand be the same as the bedding sand described above. Some specifications allow for a finer sand to be used in the joints to encourage full joints. But, it is common sense that the easier the sand goes into the joints, the easier it is for it to come out of the joints. Care should be taken to make sure the appropriate sand is sourced and inspected prior to use on any heavy vehicular application regardless of setting system.

Finally, we recommend that for both bedding and joint sand the specification specifically exclude stone screenings that may pass the C33 sieve analysis. Stone screenings tend to contain too much fine material passing the 200 sieves as well as tend to break down into small pieces, which settle out in the joints and compromise interlock. (see Tech Bullet # 5 on Bedding & Joint Sand)